

GRADE STABILIZATION STRUCTURE

STANDARD

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

SCOPE

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways, and may be full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel. It does not apply to structures designed to control the rate of flow or to regulate the water level in channels (587).

PURPOSES

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

PLANNING CONSIDERATIONS

Landscape resources. In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources. Landforms, structural materials, later elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

Water Quantity. Planning shall consider:

1. Effects on volumes and rates of runoff, evaporation, deep precolation, and ground water recharge.
2. Effects of the structure on soil water and resulting changes in plant growth and transpiration.

Water Quality. Planning shall also consider:

1. Ability of structure to trap sediment and sediment-attached substances carried by runoff.

2. Effect of structure on the susceptibility of downstream streambanks and stream beds to erosion.
3. Effects of the proposed structure on the movement of dissolved substances to ground water.
4. Effects on the visual quality of downstream water resources.

DBSIGN CRITERIA

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting.

Embankment dams. Natural Resources Conservation Service (NRCS) Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 feet in effective height and all NRCS Class (b) and Class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60.

NRCS Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 feet or less shall meet or exceed the requirements specified for ponds (378).

The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section along the center line of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

Pond size dams. If mechanical spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of the detention storage.

If the effective height of the dam is less than 20 feet and the emergency spillway has a stable grade throughout its length with no overfalls and has good vegetation along its re-entry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the two-year frequency, 24-hour duration storm.

If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre-feet, the ten-year frequency, 24-hour duration storm must be used as the minimum design storm.

Grade stabilization structures with a settled fill height of less than 15 feet and ten-year frequency, 24-hour storm runoff less than ten acre-feet, shall be designed to control the ten-year frequency storm without overtopping. An emergency spillway is not required if any mechanical spillway(s), regardless of size, in combination with storage will handle the design, storm. The embankment can be designed to meet the requirements for water and sediment control basins (638) rather than the requirements for ponds (378).

TABLE 1. - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet (3).

Maximum drainage area for Standard (1) Acres	Effective height of dam (2)	Frequency of minimum design, 24-hour duration storm
acre	feet	year
100	35 or less	2
200	20 or less	2
200	20-35	5
400	20 or less	5

- (1) When drainage area exceeds 100 acres, the provisions of the PADEP, Chapter 105 prevail.
- (2) When the greatest depth of water measured at the upstream toe of the dam at maximum water elevation exceeds 15 feet, the provisions of PADEP, Chapter 105 prevail.
- (3) When storage capacity exceeds 50 acre-feet, the provision of PADEP, Chapter 105 prevail.

Full-flow open structures. Drop, chute, and box-inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Handbook (Manual) for Conservation Practices, the National Engineering Handbook, and other applicable NRCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. If site conditions exceed those shown in Table 2, the minimum

design 24-hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. Structures must not create unstable conditions upstream or downstream. Provisions must be made to ensure re-entry of bypassed storm flows.

Toe-wall drop structures can be used if the vertical drop is four feet or less, flow are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction because of

detention storage, whichever is greater. The drop box capacity (attached to a new, or existing culvert) must equal or exceed the culvert capacity at design flow.

TABLE 2. -Design criteria for establishing minimum capacity of full-flow open structure.

Maximum drainage area (1) for standard	Vertical drop	Frequency ,of minimum design, 24-hour duration storm	
		Principal spillway capacity	Total capacity
acres	feet	year	year
450	5 or less	5	10
900	10 or less	10	25

(1) When drainage area exceeds 100 acres, the provisions of PADEP, Chapter 105 prevail.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the two-year, 24-hour storm or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provisions must be

made for safe re- entry of bypassed flow as necessary.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevation or lateral channels into deeper open channels are shown in Table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in Table 3, the 50-year frequency storm shall be used for minimum design of total capacity.

TABLE 3. - Design criteria for establishing minimum capacity of side-inlet, open-weir, or pipe-drop drainage structure.

Maximum drainage area (1) for standard	Vertical drop	Frequency of minimum design, 24-hour duration storm	
		Receiving channel depth	Total capacity
acres	feet	feet	year
450	0-5	0-10	
450	5-10	10-20	10
900	0-10	0-20	25

(1) When drainage area exceeds 100 acres, the provisions of PADEP, Chapter 105 prevail.

General criteria. Earth embankment and emergency spillways of structures for which criteria are not provided under the standard for ponds (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in Tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic clean out.

Earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, and/or lifesaving equipment shall be added as needed.

If the area is used for livestock, the structure, earthfill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary.

to prevent erosion. If climatic conditions precluded the use of vegetation, non-vegetative coverings such as gravel or other mulches may be used.

Structures. Grade stabilization structures of materials such as concrete, masonry, steel, aluminum, and treated wood shall be designed in accordance with the principles contained in National Engineering Handbook, Section 5, Hydraulics; Section 6, structural Design; Section 11, Drop Spillways; and Section 14, Chute Spillways; or Chapter 6, Structures, of the Engineering Field Handbook. structures must not create unstable conditions upstream or downstream.

Compliance with local regulations. Design, installation, and construction shall comply with state and local laws and regulations. Such compliance is the responsibility of the landowner; however, the responsible technician, before giving any technical assistance, will inform the owner of his/her responsibility for complying with all state and/or local laws and regulations.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Specified materials shall be of a quality capable of providing the stability, durability, and appearance required to achieve the planned objective with appropriate factors of safety.

Construction operations shall be carried out in such a manner that erosion, air and water pollution will be minimized.

OPERATION AND MAINTENANCE

An Operation and Maintenance Plan shall be prepared for each structure. It shall be site-specific and include, but not be limited to, normal management actions such as mowing, weed control, periodic opening and closing of water control gates, etc.; maintenance corrective actions such as needed repairs due to normal wear, replacement of components of the practice at periodic times during the life of the structure, concrete repair, riprap replacement and other similar activities. The Plan shall include guidance for annual inspections and inspections after every major runoff event.